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ABSTRACT

Data from the Stanford Test of Academic Skills Level I, administered to 10,910 tenth graders in Hawaii in Fall, 1985, are analyzed. The purposes of this report are to provide information on the effectiveness of the mathematics program in the high school, including the identification of deficiency areas and recommendations for improving instruction, and to provide a model for subsequent district and school analyses. How well the test measures program efforts and how well students are performing are each explored. Overall, tenth grade students in Hawaii performed slightly better than the national norm population, with 79 percent scoring in the average and above average ranges. Approximately 44 percent of the items measure expectations which may require performance at a level below grade 9. The test is moderately effective in assessing the attainment of some objectives, but not all, in the state mathematics program. Subtest analyses of the data indicate 20 items on which students scored lower than national norms. Appendices list the matches between test objectives and state learner objectives or performance expectations, the nonmatches, and the performance expectations not addressed. (MNS)

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ED276621

MATHEMATICS PROGRAM ANALYSIS OF GRADE 10 STANFORD ACHIEVEMENT TEST, TEST OF ACADEMIC SKILLS

Fall 1985 Administration

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Office of Instructional Services/General Education Branch • Department of Education • State of Hawaii • RB 86-9374 • March 1986

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FOREWORD

As part of the Department's competency-based thrust, the analysis of test results is being conducted and reported. Performance data from tests and other sources are critical in the educational process and should be used to assist students, improve instruction, and upgrade programs. The efforts to date by teachers, principals and specialists are making significant impact on the achievement of students as indicated by the test results.

Although recent test results indicate overall improvement statewide, it is hoped that each level within the Department will continue to conduct review and analysis of formal data to determine student needs and related intervention activities. The momentum for positive change has begun and should be maintained, if not accelerated, as we work together to provide a solid foundation for all subsequent learning.

Francis M. Hatanaka

Francis M. Hatanaka, Superintendent

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I. OVERVIEW

OVERVIEW

A. Purpose

The purposes of this report are:

1. To provide information on the effectiveness of the mathematics program in the high school, including identification of deficiency areas which require attention and the implications and recommendations for improving instruction towards the goals and objectives of the Foundation Program and Mathematics Education.

2. To provide a model for subsequent district and school analyses.

It is expected that state, district and school level improvement efforts will be directed at the identified deficiency areas.

B. Background of the Test Administration

The Stanford Achievement Test (SAT) has been administered since the mid-1970's to students of grades 2, 4, 6, 8, and 10 as a means of assessing and analyzing student performance in planning program improvement. For the purpose of this report, the data analysis and recommendations for improvement will be restricted to grade 10. The SAT Test of Academic Skills (TASK) Level I was administered to 10,910 grade 10 students in the Fall of 1985.

C. Approach for Program Analysis

The following framework guided the program planner for mathematics in the analysis process. With minor modifications or changes in focus, the framework may be used by schools or teachers in the assessment of test results for use in instructional planning and delivery.

1. How well does the test measure the program efforts? (Curriculum Validity)

   a. How well does the subtest content (items) reflect the major program emphases?

   b. Are there test items that measure what is <u>not</u> taught until later in the school experience?

   c. Are there major emphases for grade 10 that are <u>not</u> measured by this test?

2. How are the students performing? (Student Achievement)

   a. How well are the students doing statewide?

   b. Are there variations among subtest areas?

   c. Are variations what would have been expected? If so, why?

   d. Are variations consistent across all seven districts?

Each subtest was analyzed according to task description, student performance, implications for program/instruction, and recommendations for improvement.

D. General Summary of Performance

The statewide summary of group stanine results indicates that tenth grade students in Hawaii performed slightly better than the national norm population with 79% scoring in the average and above average ranges. This is 2% higher than the national norm (77%).

	Below Average %	Average %	Above Average %
National	23	54	23
Hawaii 10th Graders	21	57	22

A. Overall Analysis

The Stanford Achievement Test (SAT) Test of Academic Skills (TASK) Level I includes one mathematics subtest.

1. The curriculum validity of the test is determined by comparing the test items with the Grade 10 Foundation Program Performance Expectations and learner objectives of the Mathematics Program. Although students are in the tenth grade, the test is administered early in the Fall and measures achievement up to the end of the ninth grade. Analysis of the SAT indicates that the test is moderately effective in assessing the attainment of some of the goals, objectives, and student performance expectations of the State Mathematics Program. There are ten performance expectations of Foundation Program Objective I: Develop basic skills for learning and effective communication with others. The test does not measure five performance expectations relating to geometry and statistics. In addition, one performance expectation is measured by one item and three performance expectations are only partially measured.

   The problem-solving process is a major goal of the mathematics program as well as of the Foundation Program (Foundation Program Objective III: Develop decision-making and problem-solving skills). There are seven performance expectations of which the SAT addresses none.

   Approximately 44% of the SAT items measure expectations which may require performance at a level below Grade 9.

2. Student Performance

   The results displayed in Figure 1 on the next page indicate that although tenth grade students in Hawaii did not score as well as the national norm population on mean number right and corresponding scaled scores, the stanine distribution indicates slightly better performance by Hawaii's students. A comparison of the 1984 and 1985 results reveals the following:

   a. There is no change in the number right and in scaled scores. The scaled scores are based upon the raw scores. Scaled scores enable the interpreter to compare from grade to grade, battery to battery, and form to form, the scores within a single test area. Scaled scores are not comparable from one test area to another.

   b. There is a decrease in the percent of students scoring in the below average range, corresponding increase in the above average range and no change in the average range. The percent of students scoring in the average and above average ranges (79%) is slightly higher than the percent of students in the nation (77%) scoring in the same ranges.

	Mean Scores						Stanine Distribution								
	Number Right			Scaled Scores			Below 1 2 3			Average 4 5 6			Above 7 8 9		
	Norm	'84	'85	Norm	'84	'85	Norm	'84	'85	Norm	'84	'85	Norm	'84	'85
HAWAII TENTH GRADERS	37	34	34	196	194	194	23	22	21	54	57	57	23	21	22

Figure 1

3. Implications

Although the tenth grade performance is almost comparable to that of the norm population, there is a need to work towards improvement in all areas.

4. Recommendations

Analysis should be made of the subtest to identify those items students did not perform well on. Comparisons should be made of these items with the performance expectations and mathematics program objectives, reasons for student performance should be determined, and improvement strategies should be implemented where appropriate. Although the problem-solving process is not tested fully, a priority should be placed on the instructional delivery of the problem-solving process and development of higher level thinking skills to improve overall mathematics performance.

B. Subtest Analysis

The following is an analysis of the mathematics subtest relative to the task requirement, student performance in Hawaii as compared to national performance, implications, and recommendations. The student performance comparison is made with respect to the mean p-values in each of the item-grouping areas. The subtest is divided into nine groups in which the test items are closely related. The p-value, which gives the percent of students answering the problem correctly is used to determine what students may need help with. A comparison of local p-values with those of the national norm is used in discussing the implications which are drawn from the relationship of performance expectations with the SAT objectives.

Further study within each of the item-group areas is made for those areas in which the local p-value is lower than the national p-value. Each item with a lower p-value is listed, but only those items considered significantly lower* are discussed in the section on implications. Thus, the sections on implications and recommendations will deal primarily with identifying areas for program improvement.

*Items with local p-values at least 4 percentage points lower than the national norm are considered significantly low.

1. Description of Task

The subtest consists of 48 items which require the student to read each item and select an answer from five options. Item groupings are in nine areas: 1) numbers, symbols, and sets; 2) number properties and operations - common and decimal fractions; 4) number properties and operations - integers and exponents; 5) mathematical sentences; 6) geometry and measurement; 7) ratio and percent; 8) graphs, probability, and statistics; and 9) mathematical reasoning.

2. Student Performance

Figure 2 below compares the local and national mean p-values in each item-grouping area. The results show that students in the State of Hawaii scored slightly lower in the areas of numbers, symbols, and sets; geometry and measurement; graphs, probability and statistics; and mathematical reasoning. A comparison between the 1984 and 1985 results indicates slight decreases in two and a slight increase in one of the item-grouping areas as shown below.

ITEM GROUPING AREA	LOCAL %		National %	Difference	
	1984	1985		1984	1985
Numbers, symbols, and sets	74	74	75	-1	-1
Number properties and operations - whole numbers	79	79	79	-0-	-0-
Number properties and operations - common and decimal fractions	69	69	69	-0-	-0-
Number properties and operations - integers and exponents	73	72	72	+1	-0-
Mathematical sentences	74	74	72	+2	+2
Geometry and measurement	64	63	64	-0-	-1
Ratio and percent	63	63	60	+3	+3
Graphs, probability, and statistics	67	68	69	-2	-1
Mathematical reasoning	73	73	74	-1	-1

Figure 2

Item analysis indicates that the test objectives where students scored lower were as follows:

a. Numbers, Symbols, and Sets

1) Identifies definition of a prime number (item 22).

2) Identifies a relationship between two sets (item 29*).

3) Chooses correct interpretation of a Venn diagram (item 47).

b. Number Properties and Operations - Whole Numbers

1) Recognizes one as the multiplicative identity (item 24*).

2) Solves for variable in an equation (item 37*).

3) Applies associative property of multiplication (item 45).

c. Number Properties and Operations - Common and Decimal Fractions

1) Adds two common fractions having like denominators, with renaming (reduction) (item 10).

2) Identifies relative value of an improper fraction (item 15*).

3) Identifies relative value of a common fraction (item 23*).

4) Solves a one-step word problem by adding with mixed numbers and converting inches to feet (item 35*).

5) Finds least common denominator of three common fractions (item 44).

d. Number Properties and Operations - Integers and Exponents

1) Finds a product when one factor is given in exponential form (item 31).

2) Determines distance between two points on a number line (item 42).

e. Geometry and Measurement

1) Indicates meaning of a metric prefix (item 46).

f. Ratio and Percent

1) Solves a rate problem (item 16).

2) Finds a total when a part and its percent of total are given (item 41).

---

*Items with local p-values at least 4 percentage points lower than the national norm are considered significantly low.

g. Graphs, Probability, and Statistics

1) Solves a word problem by identifying percents on a circle graph (item 19).

2) Solves a word problem by determining an amount represented by a percent given on a circle graph (item 20*).

h. Mathematical Reasoning

1) States solution of a word problem as a mathematical expression (item 40).

2) Solves a word problem by deduction (item 43*).

Specific items in each of the above areas where students scored significantly lower were items 15, 20, 23, 24, 29, 35, 37, and 43. The p-values for all of these items were also significantly lower in 1984.

C. Implications

Tenth grade students in Hawaii did not do as well as the norm group on specific items that require:

1. identifying the relative value of an improper fraction,

2. solving a word problem by determining an amount represented by a percent given on a circle graph,

3. identifying the relative value of a common fraction,

4. recognizing one as the multiplicative identity,

5. identifying a relationship between two sets,

6. solving a one-step word problem by adding with mixed numbers and converting inches to feet,

7. solving for a variable in an equation, and

8. solving a word problem by deduction.

Recognizing one as the multiplicative identity and solving a one-step word problem by adding with mixed numbers and converting inches to feet are objectives that will have been met by the end of the tenth grade. Identifying a relationship between two sets does not match any mathematics learner objective or performance expectation of the Foundation Program. Solving for a variable in an equation is addressed in all Level A courses and solving a word problem by deduction is an objective of the Core Geometry course. However, the first three objectives are related to performance expectations or mathematics learner objectives that students should have met by the end of the eighth grade. Consequently, there is a need to improve student performance in all areas.

*Items with local p-values at least 4 percentage points lower than the national norm are considered significantly low.

D. Recommendations

Continue to pursue the performance expectations with more emphasis placed on related learner objectives that address concepts where p-values were significantly lower than the national norm. Attention should be given to developing the concept of a fraction and computing with fractions which are problem areas of the sixth and eighth grades. Program improvement should also include a variety of problem-solving experiences and approaches which require students to apply the higher-level thinking, decision-making, and evaluative skills that are necessary for students to function as responsible citizens in society. The essential competencies and graduation requirements should also be a major consideration in program planning to ensure that students will have acquired all the necessary learnings by the time they graduate.

APPENDIX

Appendix A

Grade 10 SAT Item Matches

Item #	SAT Objective	Learner Objective (LO) Performance Expectation (PE)	Grade
1	Adds a broken column of three numbers.	Adds and subtracts whole numbers; multiplies any whole number by a 2-digit number; and divides any whole number by a 1-digit number.	6 PE
2	Subtracts a three-digit number from a four-digit number, with renaming.	Adds and subtracts whole numbers; multiplies any whole number by a 2-digit number; and divides any whole number by a 1-digit number.	6 PE
3	Renames a standard numeral in expanded notation.	Writes numerals in expanded and exponential notation.	7-8 LO
4	Identifies a number, given its prime factors.	Investigates how to determine prime and composite numbers in a variety of ways.	7-8 LO
		Investigates a variety of ways to determine least common multiples and common factors.	7-8 LO
5	Divides by a one-digit number, with an internal remainder.	Adds and subtracts whole numbers; multiplies any whole number by a 2-digit number; and divides any whole number by a 1-digit number.	6 PE
6	Multiplies common fractions.	Multiplies and divides mixed and common fractions.	6 PE
		Adds, subtracts, multiplies and divides fractions and integers.	8 PE 10 PE
7	Identifies the decimal equivalent of a common fraction.	Expresses fractions as decimals to hundredths.	5 LO
8	Reduces a fraction to lowest terms.	Finds equivalent fractions in a variety of ways.	4 LO
9	Identifies a standard numeral from its word form.	Reads, writes (using words and symbols) and verbalizes mathematical ideas in order to communicate quantitative information.	7-8 LO
10	Adds two common fractions having like denominators, with renaming (reduction).	Adds and subtracts like-denominator fractions and commonly-used decimals.	6 PE
		Adds, subtracts, multiplies and divides fractions and integers.	8 PE 10 PE

Item #	SAT Objective	Learner Objective (LO) or Performance Expectation (PE)	Grade
11	Names a geometric figure from a description.	Uses correct terminology in describing the properties of geometric figures.	6 PE 8 PE 10 PE
12	Subtracts with two common fractions having unlike denominators, no reduction.	Adds and subtracts commonly-used fractions (mixed and common) with unlike denominators.	6 PE
		Adds, subtracts, multiplies and divides fractions and integers.	8 PE 10 PE
13	Identifies the place value represented by a digit.	Reads, writes, and orally names numerals to 100,000 and identifies the place value of each digit.	4 LO
14	Adds with negative integers.	Adds, subtracts, multiplies and divides fractions and integers.	8 PE 10 PE
15	Identifies the relative value of an improper fraction.	Compares mixed numbers.	5 LO
16	Solves a rate problem.	Solves simple ratio, proportion, and percent problems.	6 PE
		Solves ratio, proportion and percent problems.	8 PE 10 PE
17	Solves a rate problem.	Solves simple ratio, proportion, and percent problems.	6 PE
		Solves ratio, proportion and percent problems.	8 PE 10 PE
18	Solves a word problem by computing a percent represented on a circle graph.	Solves simple ratio, proportion and percent problems.	6 PE
		Solves ratio, proportion and percent problems.	8 PE 10 PE
		Extends ability to read, interpret, and make graphs and tables.	7-8 LO
19	Solves a word problem by identifying percents on a circle graph.	Solves simple ratio, proportion and percent problems.	6 PE
		Solves ratio, proportion and percent problems.	8 PE 10 PE
		Extends ability to read, interpret, and make graphs and tables.	7-8 LO
		Reads and interprets graphs, tables, and commonly-used schedules.	6 PE

Item #	SAT Objective	Learner Objective (LO) or Performance Expectation (PE)	Grade
20	Solves a word problem by determining an amount represented by a percent given on a circle graph.	Solves simple ratio, proportion and percent problems.	6 PE
		Solves ratio, proportion and percent problems.	8 PE 10 PE
		Extends ability to read, interpret, and make graphs and tables.	7-8 LO
		Reads, and interprets graphs, tables, and commonly-used schedules.	6 PE
21	Finds the average of three numbers.	Finds averages.	5 LO
22	Identifies the definition of a prime number.	Investigates characteristics of prime and composite numbers and classifies numbers less than 50 as prime or composite.	5 LO
23	Identifies the relative value of a common fraction.	Orders fractions from least to greatest using "<" and ">".	5 LO
24	Recognizes one as the multiplicative identity.	Uses algebraic techniques to solve problems.	8 PE 10 PE 12 PE
25	Indicates the exponential notation for a number repeated as a factor.	Writes numerals in expanded or exponential notation.	7-8 LO
26	Solves a three-step, money word problem.	Uses operations of addition and subtraction involving money expressions.	4 LO
		Computes measurements using the four basic operations.	6 PE 8 PE
27	Finds the average of five numbers.	Finds averages.	5 LO
28	Solves for the variable in an equation.	Uses algebraic techniques to solve problems.	8 PE 10 PE 12 PE
29	Identifies a relationship between two sets.	No match.	
30	Locates the decimal point in the product of two decimals, no multiplication.	Adds, subtracts, multiplies and divides decimals.	8 PE 10 PE
31	Finds a product when one factor is given in exponential form.	Performs the four basic operations with simple rational expressions.	Core Algebra

Item #	SAT Objective	Learner Objective (LO) or Performance Expectation (PE)	Grade
32	Determines the value of a linear expression with two unknowns, given the value of each.	Evaluates algebraic expressions, including the order of operations.	Algebra 1A
33	Solves a one-step, money word problem by subtracting.	Uses operations of addition and subtraction involving money expressions.	4 LO
		Computes measurements using the four basic operations.	6 PE 8 PE
34	Multiplies a three-digit number by a two-digit number, no renaming.	Adds and subtracts whole numbers; multiplies any whole number by a 2-digit number; and divides any whole number by a 1-digit number.	6 PE
35	Solves a one-step word problem by adding with mixed numbers and converting inches to feet.	Adds, subtracts, multiplies and divides fractions and integers.	8 PE 10 PE
		Computes measurements using the four basic operations.	6 PE 8 PE
36	Solves a one-step, money word Problem by computing a percent of discount.	Solves simple ratio, proportion and percent problems.	6 PE
		Solves ratio, proportion, and percent problem.	8 PE 10 PE
37	Solves for the variable in an equation.	Solves simple equations in one unknown.	Level A
38	Finds a percent of a number.	Solves simple ratio, proportion and percent problems.	6 PE
		Solves ratio, proportion, and percent problems.	8 PE 10 PE
39	Determines the missing data needed to solve a word problem.	Gathers relevant information to solve the problem.	FPO III 6 PE
40	States the solution of a word problem as a mathematical expression.	Uses algebraic techniques to solve problems.	8 PE 10 PE 12 PE
41	Finds a total when a part and its percent of the total are given.	Solves simple ratio, proportion and percent problems.	6 PE
		Solves ratio, proportion, and percent problems.	8 PE 10 PE
42	Determines the distance between two points on a number line.	Adds, subtracts, multiplies and divides integers.	8 PE 10 PE

Item #	SAT Objective	Learner Objective (LO) or Performance Expectation (PE)	Grade
43	Solves a word problem by deduction.	Is aware of how statements in mathematics can be organized into a deductive system, that is, a system consisting of undefined terms, axioms, theorems, and relationships.	Core Geometry
44	Finds the least common denominator of three common fractions.	Finds equivalent fractions in a variety of ways.	4 LO
45	Applies the associative property of multiplication.	Uses algebraic techniques to solve problems.	8 PE 10 PE 12 PE
46	Indicates the meaning of a metric prefix.	Computes measurements using the four basic operations.	6 PE 8 PE
47	Chooses the correct interpretation of a Venn diagram.	No match.	
48	Identifies a mathematical equation that represents a verbally stated relationship.	Uses algebraic techniques to solve problems.	8 PE 10 PE 12 PE

Appendix B

Items Not Matched to Grade 10 PEs

Item #	SAT Objective	Grade PE/LO
1	Adds a broken column of three numbers.	6 PE
2	Subtracts a three-digit number from a four-digit number, with renaming.	6 PE
3	Renames a standard numeral in expanded notation.	7-8 LO
4	Identifies a number, given its prime factors.	7-8 LO
5	Divided by a one-digit number, with an internal remainder.	6 PE
7	Identifies the decimal equivalent of a common fraction.	5 LO
8	Reduces a fraction to lowest terms.	4 LO
9	Identifies a standard numeral from its word form.	7-8 LO
13	Identifies the place value represented by a digit.	4 LO
15	Identifies the relative value of an improper fraction.	5 LO
21	Finds the average of three numbers.	5 LO
22	Identifies the definition of a prime number.	5 LO
23	Identifies the relative value of a common fraction.	5 LO
25	Indicates the exponential notation for a number repeated as a factor.	7-8 LO
26	Solves a three-step, money word problem.	4 LO 6 PE 8 PE
27	Finds the average of five numbers.	5 LO
29	Identifies a relationship between two sets.	--

Item #	SAT Objective	Learner Objective (LO) or Performance Expectation (PE)	Grade
43	Solves a word problem by deduction.	Is aware of how statements in mathematics can be organized into a deductive system, that is, a system consisting of undefined terms, axioms, theorems, and relationships.	Core Geometry
44	Finds the least common denominator of three common fractions.	Finds equivalent fractions in a variety of ways.	4 LO
45	Applies the associative property of multiplication.	Uses algebraic techniques to solve problems.	8 PE 10 PE 12 PE
46	Indicates the meaning of a metric prefix.	Computes measurements using the four basic operations.	6 PE 8 PE
47	Chooses the correct interpretation of a Venn diagram.	No match.	
48	Identifies a mathematical equation that represents a verbally stated relationship.	Uses algebraic techniques to solve problems.	8 PE 10 PE 12 PE

Appendix B

Items Not Matched to Grade 10 PEs

Item #	SAT Objective	Grade PE/LO
1	Adds a broken column of three numbers.	6 PE
2	Subtracts a three-digit number from a four-digit number, with renaming.	6 PE
3	Renames a standard numeral in expanded notation.	7-8 LO
4	Identifies a number, given its prime factors.	7-8 LO
5	Divided by a one-digit number, with an internal remainder.	6 PE
7	Identifies the decimal equivalent of a common fraction.	5 LO
8	Reduces a fraction to lowest terms.	4 LO
9	Identifies a standard numeral from its word form.	7-8 LO
13	Identifies the place value represented by a digit.	4 LO
15	Identifies the relative value of an improper fraction.	5 LO
21	Finds the average of three numbers.	5 LO
22	Identifies the definition of a prime number.	5 LO
23	Identifies the relative value of a common fraction.	5 LO
25	Indicates the exponential notation for a number repeated as a factor.	7-8 LO
26	Solves a three-step, money word problem.	4 LO 6 PE 8 PE
27	Finds the average of five numbers.	5 LO
29	Identifies a relationship between two sets.	--

Item #	SAT Objective	Grade PE/LO
31	Finds a product when one factor is given in exponential form.	Core Algebra LO
32	Determines the value of a linear expression with two unknowns, given the value of each.	Algebra 1A LO
33	Solves a one-step, money word problem by subtracting.	4 LO 6 PE 8 PE
34	Multiplies a three-digit number by a two-digit number, no renaming.	6 PE
37	Solves for the variable in an equation.	Level A LO
39	Determines the missing data needed to solve a word problem.	FPO III 6 PE
43	Solves a word problem by deduction.	Core Geometry LO
44	Finds the least common denominator of three common fractions.	4 LO
46	Indicates the meaning of a metric prefix.	6 PE 8 PE
47	Chooses the correct interpretation of a Venn diagram.	--

Appendix C

Grade 10 PEs Not Addressed

Performance Expectations	Comments
FPO I: Develop Basic Skills for Learning and Effective Communication With Others	
Adds, subtracts, multiplies and divides decimals.	Partial by one item.
Adds, subtracts, multiplies and divides fractions and integers.	Partial.
Computes measurements of common plane and solid geometric figures.	No match.
Describes and explains uses and misuses of basic statistical measurements.	No match.
Calculates and interprets statistical measurements from a set of data.	No match.
Uses correct terminology in describing the properties of geometric figures.	Match by one item.
Explains relationships of the parts of a geometric figure and among geometric figures.	No match.
Makes, reads, and interprets graphs, tables, and commonly-used schedules.	Partial by two items.
FPO III: Develop Decision-Making and Problem-Solving Skills	
Identifies, clarifies, and states a problem and develops criteria for examining alternatives in solving the problem.	No match.
Gathers information from various sources and analyzes and organizes the information to facilitate the formulation of alternatives.	No match.
Formulates hypotheses about a problem based on available information.	No match.
Applies the criteria established to select an alternative.	No match.
Evaluates the alternative selected for its effectiveness.	No match.
Draws conclusions or generalizations based on the alternatives or hypotheses and related information.	No match.
Validates and reports the conclusions and modifications, if any.	No match.